Training Plan

C5. "Joint Summer School on innovative applications of Robotics and Machine Learning in maritime industry" – NTNU

Country of Venue: NTNU, Norway

Period: 05-09.09.2022

Participants:

30 participants, of which 20 students from partner universities (10 students from each university) and 10 academic staff from partner universities (5 from each university).

Objects:

- ✓ to develop and improve innovative learning/teaching practices and tools using VTP online educational platforms and to improve distance learning methods for students and teachers in the marine intelligent technologies area, etc.
- ✓ to allow students and teachers to work together in multinational and multidisciplinary groups;
- ✓ to provide knowledge and skills to facilitate the increase of the insertion on the labor market of graduates.

Topic:

I. Practical applications in marine operation

Day 1:

1. **Digital twin for marine operation,**

Topics covered: virtual prototyping; digital twin concept and properties; digital twin system for marine design, operation, and maintenance;

2. **Digital twin systems in NTNU Ålesund,**
   Topic covered: sensor data transmission, storage, and visualization; twinship of R/V Gunnerus vessel;

Day 2:

1. **Co-simulation: the fundamental of the digital twin system,**
   Topic covered: co-simulation background; literature of co-simulation; functional mockup interface; functional mockup unit (FMU);

2. **Co-simulation platform in NTNU Ålesund,**

Topic covered: VICO system presentation (system structure, functionality, and examples); VICO system installation and simple practices.

Day 3:

1. **Co-simulation of the marine system using VICO,**
   Topic covered*:* FMUs of the R/V Gunnerus vessel; FMU configuration; Scenario setting; a practice on co-simulation of the test vessel:

2. **Case study of co-simulation of the R/V Gunnerus vessel,**
   Topic covered: zigzag maneuver and waypoint tracking applications; a practice on creating one's own FMU controller for zigzag maneuvering

Day 4:

1. **Onboard support tools based on VICO,**
   Topic covered: parameter identification; dead reckoning, sea state estimation; engine diagnosis and prognosis; thruster failure detection;

2. **Case study of onboard support of the R/V Gunnerus vessel,**
   Topic covered: neural-network-based force allocator; ship motion prediction

Day 5:

1. **Summary and final project,**
   Topic covered: summary of course content; introduce final projects

II. Machine learning applications in the maritime industry

Day 1:

1. **Machine learning introduction,**

Topics covered: machine learning concept, history, classification, and applications;

2. **Machine learning for ship autonomy**,

Topic covered: a literature review of the autonomous ship; ship motion modeling and control; a practice on ship dynamic modeling and simulation

Day 2:

1. **Neural network introduction,**

Topics covered: neural network concept, applications; backpropagation method;

2. **Feedforward neural network for ship autonomy**,

Topic covered: dataset generation; PID control for DP operation; neural-network-based DP controller

Day 3:

1. **Parameter identification techniques,**

Topics covered*:* least square method; support vector machine; genetic algorithm;

2. **Case study of parameter identification of R/V Gunnerus vessel**,

Topic covered**:** test methods in simulation; test methods with real data of the vessel

Day 4:

1. **Introduction to deep learning,**

Topics covered: deep learning concept, background, and applications; deep learning in mechanical system health diagnosis;

2. **Ship engine diagnosis and prognosis case study,**

Topic covered: *PyTorch introduction and practice; methods for remaining useful life; a practice on deep learning for prognostics and health management*

Day 5:

1. **Summary and final project,**

Topic covered: summary of course content; introduce final projects